

Evaluating the Impacts of Large-Scale Urbanization on Regional Energy and Water Cycles Using a Coupled Modeling and Remote Sensing Framework

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Project Objective:

The goal of this project was to develop a coupled modeling and remote-sensing framework to improve understanding of regional scale urban-atmosphere interactions in water-stressed areas.

The developed system can be used to predict future climate impacts on urbanized land surfaces and evaluate feedbacks to regional climate.

FY09 Results:

The NOAA land surface model, coupled with an urban canopy model (NOAH-UCM), was evaluated over various Los Angeles urban regions (Santa Monica, Downtown Los Angeles and Long Beach) at a spatial resolution of 30m forced by ground based observations (CIMIS, NCDC and LADPW). Remote sensing data and other ground-based observations were used for model validation. There are clear differences in fluxes and surface temperatures depending on vegetation type and urban fraction among the three regions. In Santa Monica, the sensible heat flux is higher while the ground heat flux and surface temperature are lower compared to downtown Los Angeles. In Long Beach, the ground heat flux and surface temperature are lower compared to downtown Los Angeles, but not as low as values in Santa Monica. Surface temperature discrepancies discovered between the NOAA and UCM parameterizations are a subject of continuing investigation.



Figure 1. NOAA land cover map (30m) of the greater Los Angeles area. The three study regions; Santa Monica, downtown Los Angeles, and Long Beach; are indicated on the map (NOAA-CSC data).

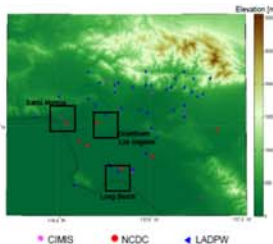


Fig 2. Data Station Map (7 NCDC stations, 6 CIMIS stations, and 41 LADPW stations are indicated on the map).

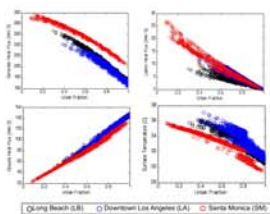


Figure 3. Urban fraction vs modeled NOAA-UCM average daytime (a) sensible flux, (b) latent heat flux, (c) ground heat flux and (d) surface temperature for three regions during summer for 2003.

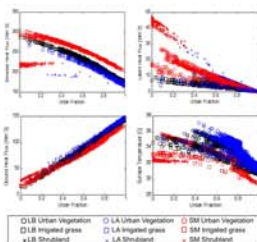


Figure 4. Urban Fraction vs Average Daytime (a) Sensible flux, (b) Latent heat flux, (c) Ground heat flux and (d) Surface Temperature for All Locations with Urban Vegetation, Grass, or Shrubland for three regions during summer for WY 2003.

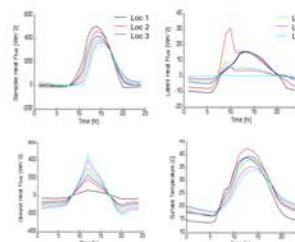


Figure 5. NOAA-UCM average diurnal (a) Sensible flux, (b) Latent heat flux, (c) Ground heat flux and (d) Surface Temperature for Six Locations (1-6) in Downtown Los Angeles region. Locations have different vegetation types and urban fraction (urban fraction 0.1 (Loc 1), 0.43 (Loc 2), 0.57 (Loc 3), 0.75 (Loc 4), 0.87 (Loc 5) and 0.98 (Loc 6))

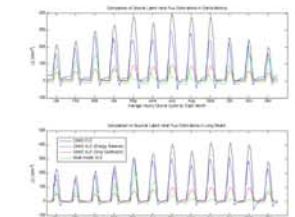


Figure 6. Comparison of Noah monthly diurnal latent heat fluxes to CIMIS Latent Heat Fluxes Average hourly diurnal CIMIS potential latent heat fluxes, CIMIS actual latent heat fluxes based on a crop factor of 0.24, CIMIS actual latent heat fluxes based on energy balance, and Noah latent heat fluxes in Santa Monica and Long Beach for each month of the year.

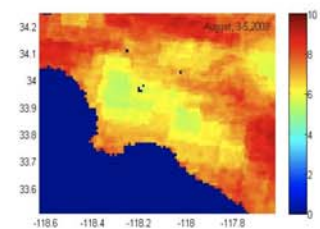


Fig 7. MODIS derived daily potential evapotranspiration for a summer day (PET, mm/day) derived using Kim and Hogue, 2008.

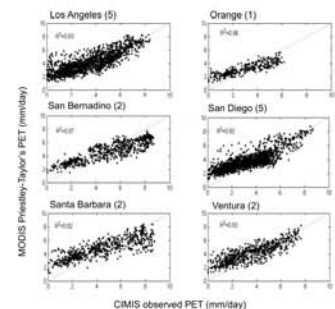


Figure 8. Comparison between CIMIS PET (x-axis) and MODIS PET (y-axis) aggregated for southern California counties (daily time step). The coefficient of determination (R^2) is presented.

Benefits to NASA and JPL:

- Enable insight on the dynamics of urban land surfaces and their importance in regional and global climate studies
- Enable support of the on-going development of an integrated Earth system model for evaluating the spatial and temporal variability of current land surface fluxes
- Identify gaps in current remote-sensing platforms with respect to urban-atmosphere observations and potential measurements and techniques relevant to future NASA missions such as SMAP

Publications:

- [1] Kim, J., and T.S. Hogue, 2008: Evaluation of a MODIS-based Potential Evapotranspiration Product at the Point-scale, *Journal of Hydrometeorology*, 9: 444-460.
- [2] Kim, J., and T.S. Hogue, 2008: Downscaled Soil Moisture by Integration of MODIS and AMSR-E products. NASA Microwave Remote Sensing Workshop, Oxnard, CA.
- [3] Kim, J., and T.S. Hogue, 2008: Coupling NLDAS Model Output with MODIS Products for Improved Spatial Evapotranspiration Estimates, AGU Fall Meeting, San Francisco, CA.
- [4] Weil, M., 2009: Evaluation of the NOAA-UCM Coupled Model for Urban Land Surfaces in the Los Angeles Basin, M.S. Thesis, Dept. of Civil and Env. Eng., UCLA, August, 2009.
- [5] Kim, J., 2009: Development of a Satellite-based Evapotranspiration Algorithm for Semi-arid Regions, Ph.D. Dissertation, Dept. of Civil and Env. Eng., UCLA, September, 2009.